A Tool for Predicting the Wind Power Production of Offshore Wind Plants

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Outline

- System characteristics
- Configuration examples
- Reliable uncertainty intervals
- Final remarks

Prediction of wind power

In areas such as the Western part of Denmark and the northern part of Germany, reliable wind power predictions are needed in order to ensure safe and economic operation of the power system.

Accurate wind power predictions are needed with different prediction horizons in order to ensure

- (a few hours) efficient and safe use of regulation power (spinning reserve) and the transmission system,
- (12 to 36 hours) efficient trading on the Nordic power exchange, NordPool,
- (days) optimal operation of the large central CHP plants.

Predictions of wind power are needed both for the total supply area as well as on a regional scale.

For all the major Danish power utilities with respect to wind power the required wind power predictions are provided by a prediction tool – **Wind Power Prediction Tool (WPPT)** – developed at IMM/DTU.

Modelling approach

WPPT can be used to predict the power production for individual wind farms (offshore or onshore), or for wind turbines distributed over a larger area. The wind turbines in the region may be grouped according to:

- Geographical distribution ideally following the weather regions.
- Legislation governing the connection (in Denmark the wind turbines in each sub-area have been grouped in prioritized production and non-prioritized production).
- Other relevant criterias.

Depending on the configuration WPPT requires input from the following sources:

- Online measurements of wind farm prod. (updated every 5min. – 1hr).
- Aggregated high resolution energy readings from all wind turbines in the groups defined above (updated with a delay of 3-5 weeks).
- Forecasts of wind speed and wind direction covering wind farms and sub-areas (horizon 0–48(120)hrs updated 2–4 times a day).
- Other measurements/predictions (local wind speed, stability, etc. can be use)

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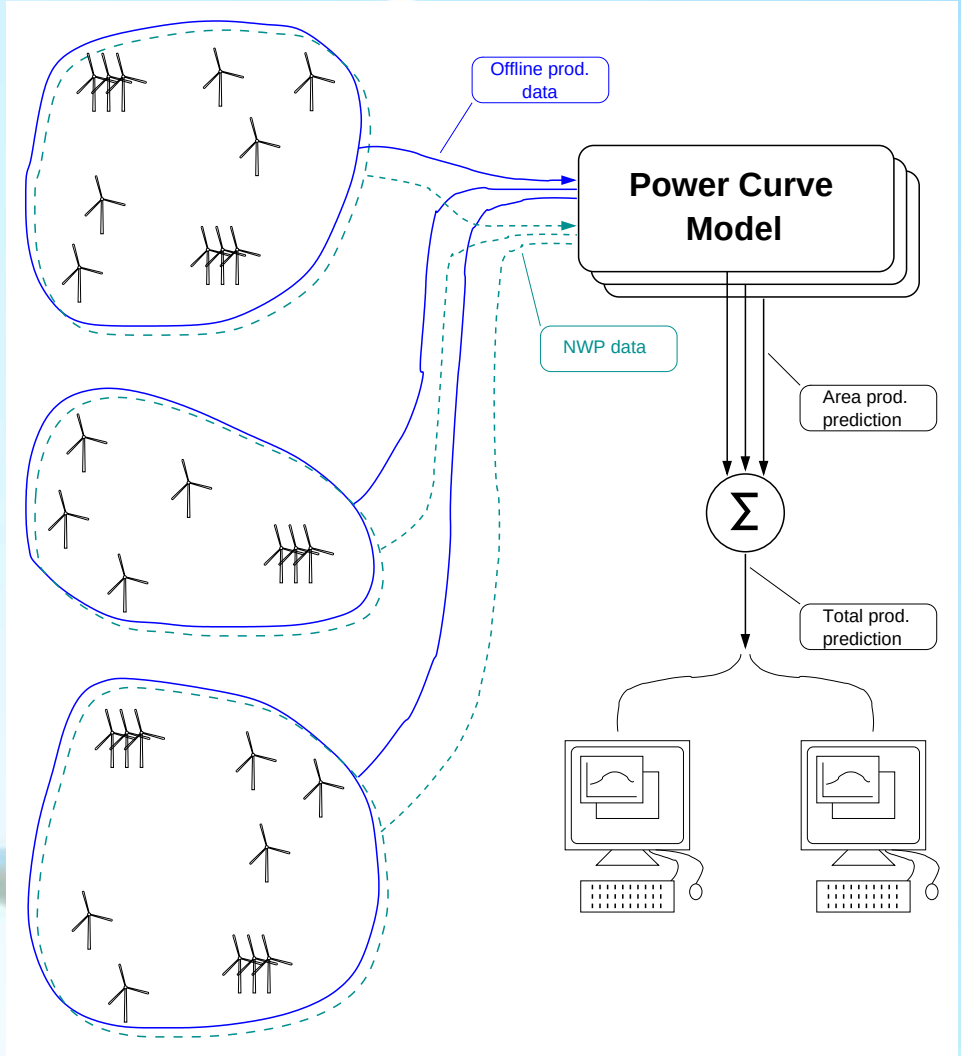
Configuration Example No. 1

This configuration of WPPT is used by a TSO in Denmark. The following characterizes the installation:

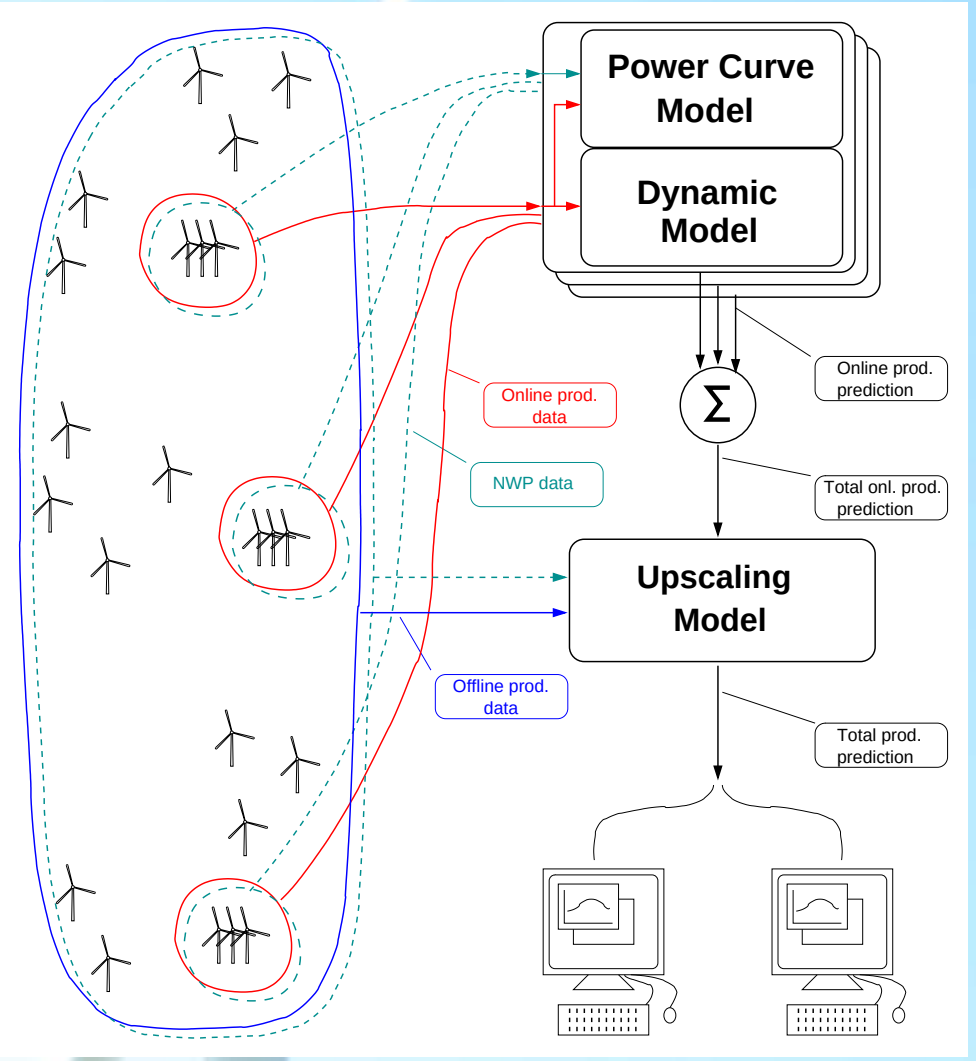
- A large number of wind farms and stand-alone wind turbines.
- Frequent changes in the wind turbine population as old wind turbines are decommissioned and replaced by new and larger machines.
- Offline production data with a resolution of 15 min. is available for more than 99% of the wind turbines in the area. The data is released with a delay of 3-5 weeks.
- No online data enters the models.



Configuration Example No. 2

This configuration of WPPT is used by a large wind farm owner in Denmark. Characteristics for the installation:

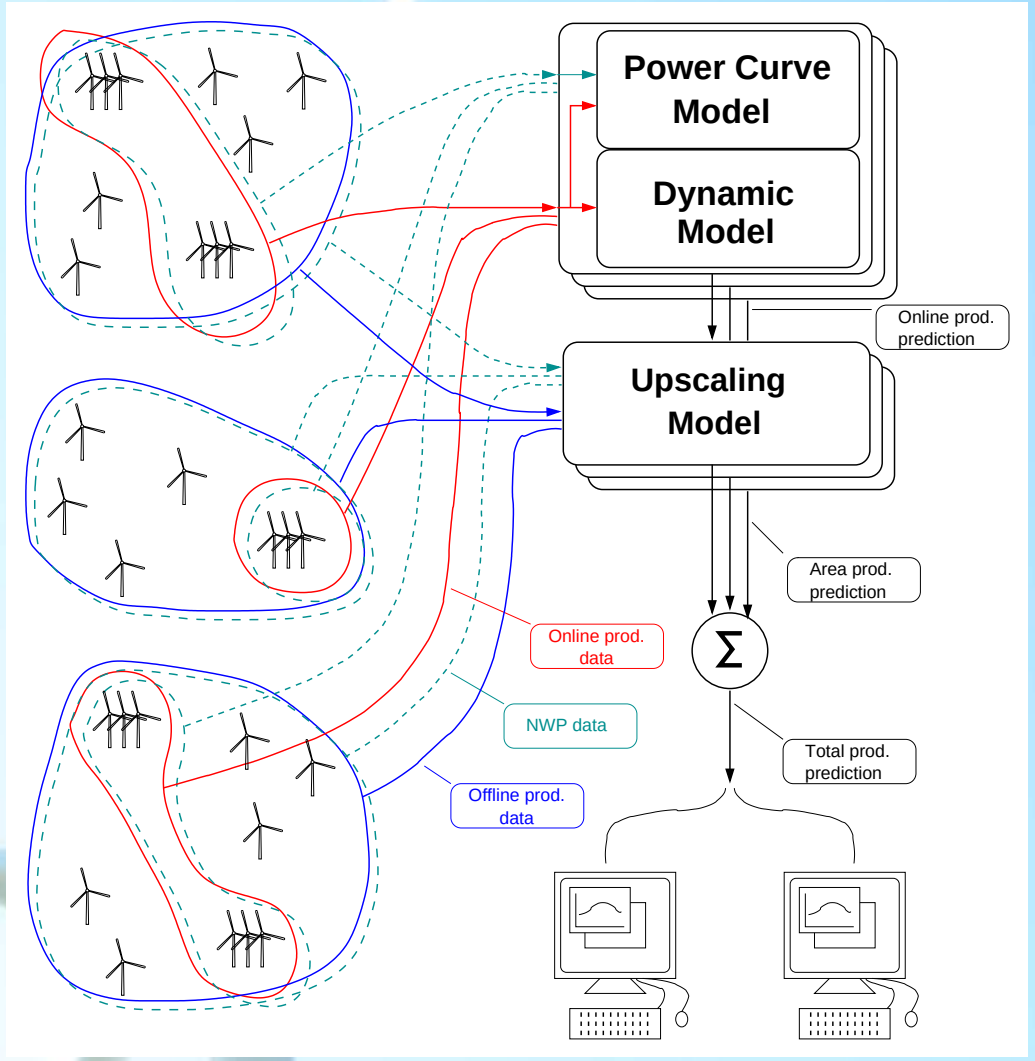
- A reasonable (< 20) number of wind farms.
- Infrequent changes in configuration for the wind farms. The number of online wind farms is not expected to change much.
- Online data for all wind farms of the owner are available.
- Offline production data with a resolution of 15 min. is available for more than 99% of the wind turbines in the area as a grand total. The data is released with a delay of 3-5 weeks.



Configuration Example No. 3

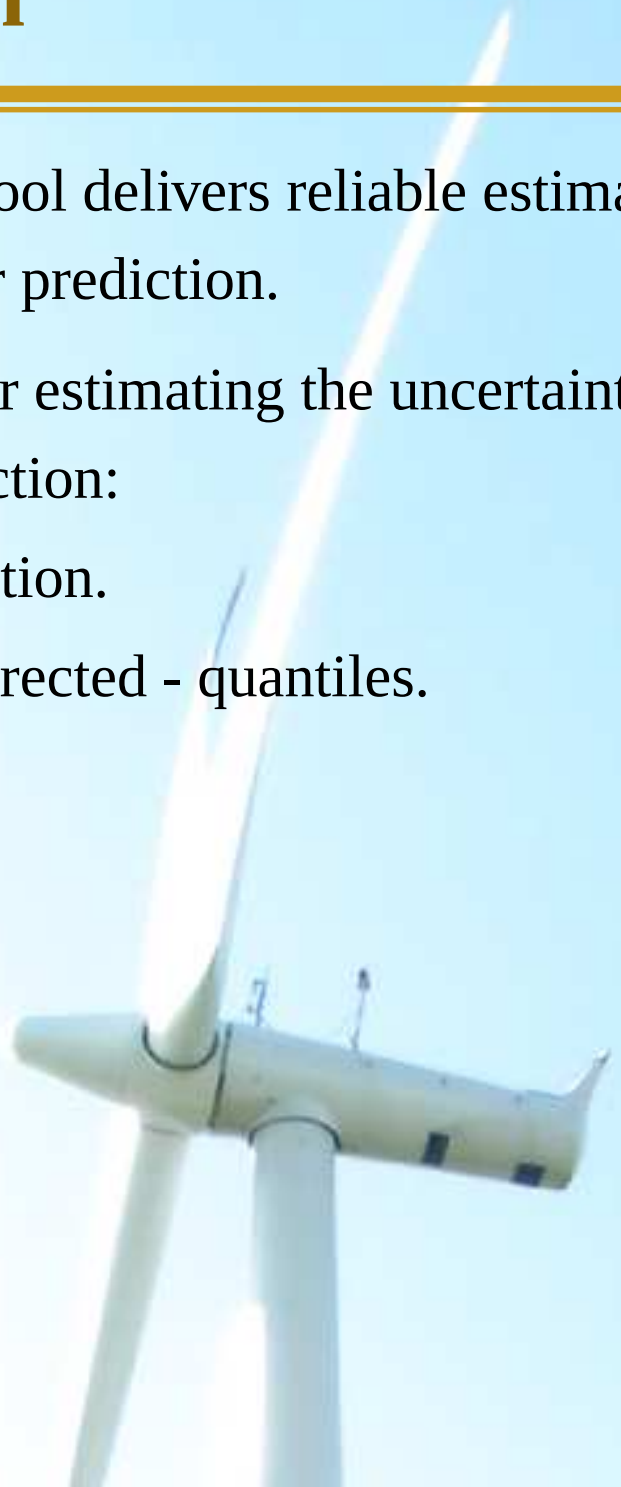
This configuration of WPPT is used by a TSO in Denmark. Characteristics for the installation:

- A large number of wind farms and stand-alone wind turbines.
- Frequent changes in the wind turbine population.
- Offline production data with a resolution of 15 min. is available for more than 99% of the wind turbines in the area.
- Online data for a large number of wind farms are available. The number of online wind farms increases quite frequently.



Uncertainty estimation

- It is crucial that a prediction tool delivers reliable estimates of the uncertainty of the wind power prediction.
- We consider three methods for estimating the uncertainty of the forecasted wind power production:
  - Adaptive variance estimation.
  - Ensemble based - but corrected - quantiles.
  - Quantile regression.



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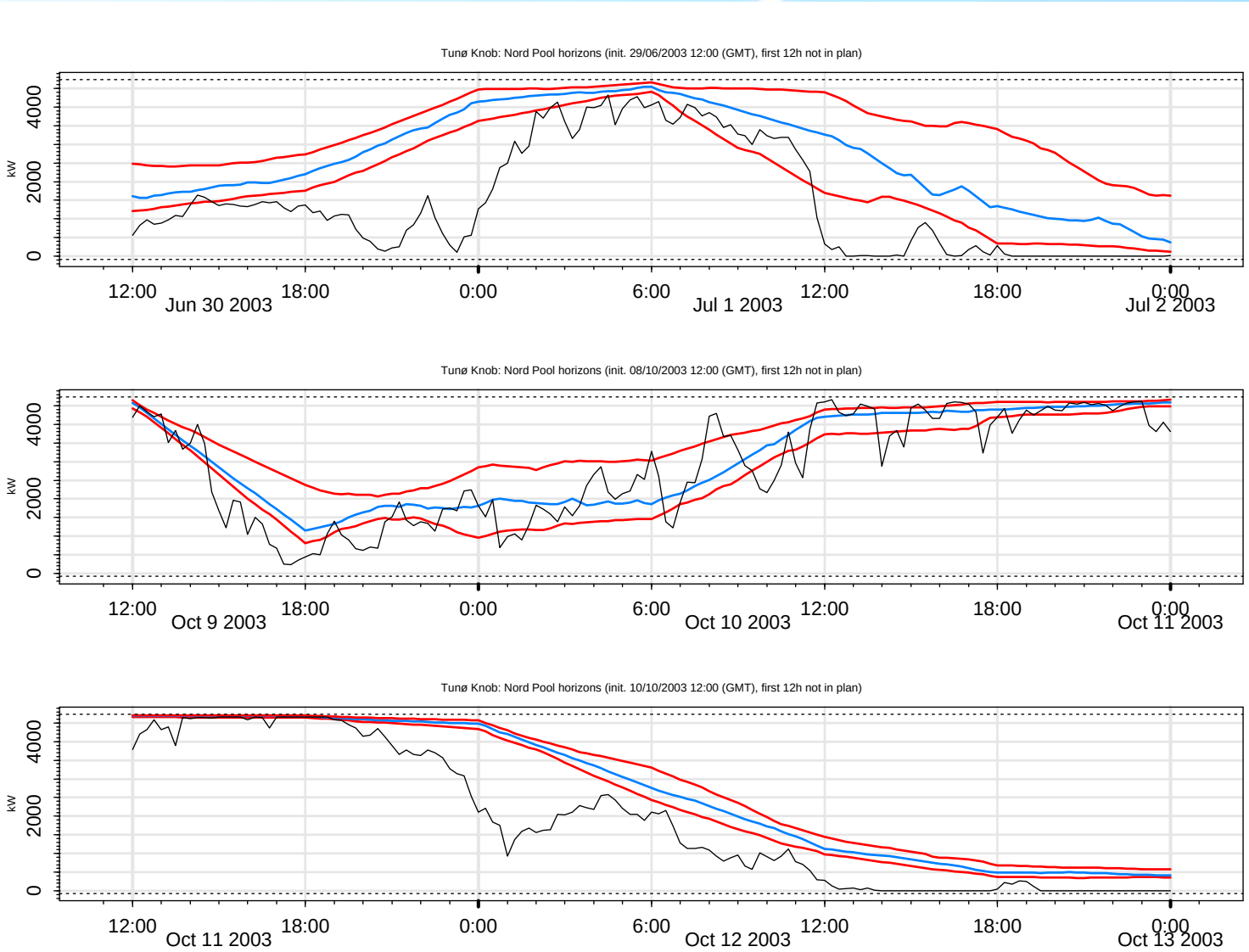
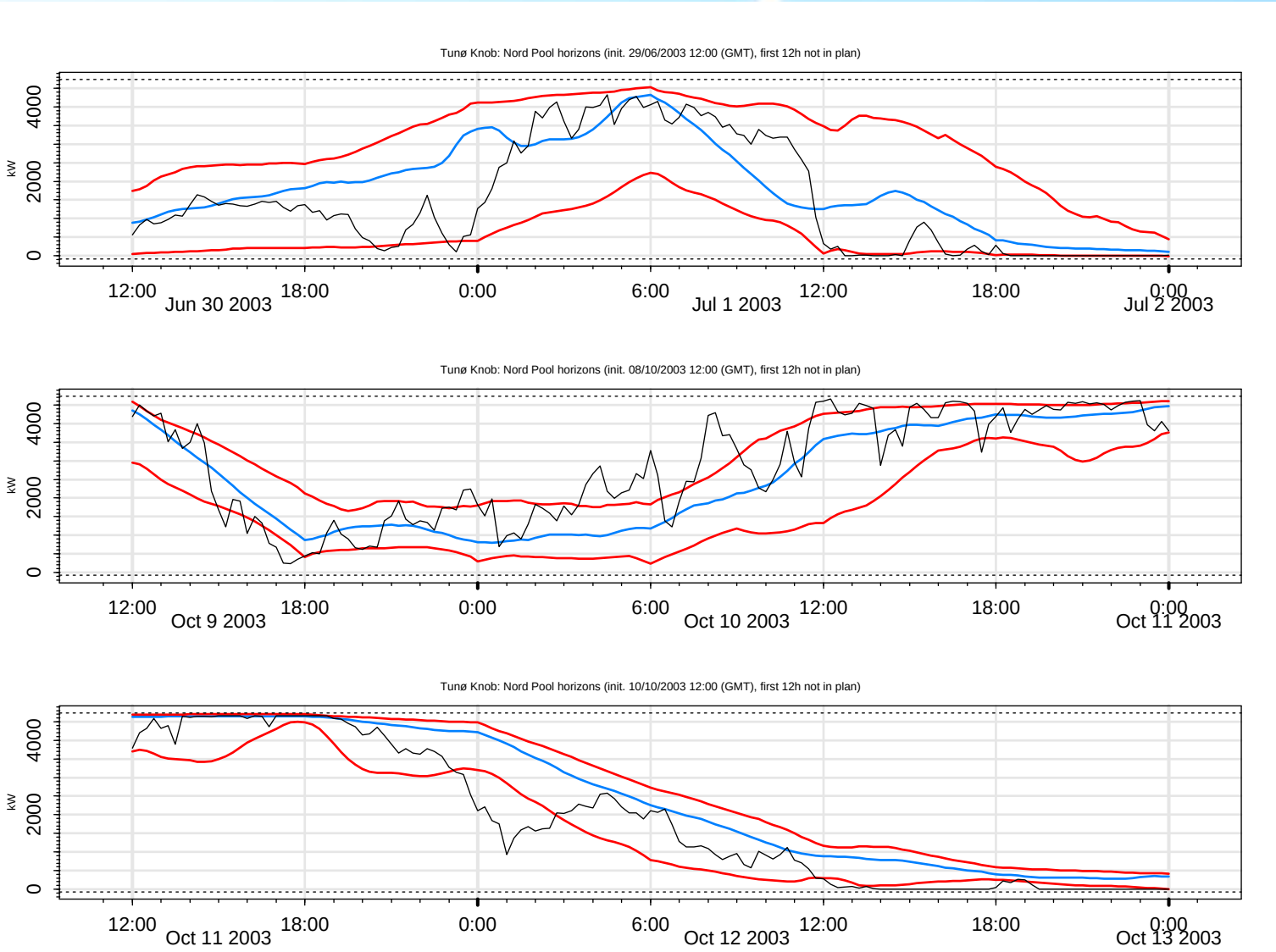
Raw quantiles – directly by MET ensembles

ECMEF, Tunø (offshore park), 29/6, 8/10, 10/10 (2003). 25%, 50%, 75%, quantiles.



Quantiles – corrected by stat. model

Tunø (offshore park), 29/6, 8/10, 10/10 (2003). 25%, 50%, 75%, quantiles.



- WPPT (Wind Power Prediction Tool) is installed at the following Danish utilities:
  - Eltra – TSO for the western part of Denmark (*www.eltra.dk*)
  - Elsam – CHP and wind farm owner in the western part of Denmark (*www.elsam.com*).
  - Elkraft – TSO for the eastern part of Denmark (*www.elkraft.dk*).
  - E2 – CHP and wind farm owner in the eastern part of Denmark (*www.e2.dk*).
- It is installed – or going to be installed in the near future – at the following utilities outside Denmark:
  - Nuon (Holland)
  - ESB (Ireland)
  - EDF (France)
  - Sotavento (Spain)
  - EWE (Germany)
  - PPC (Greece)


Thank you for your attention!